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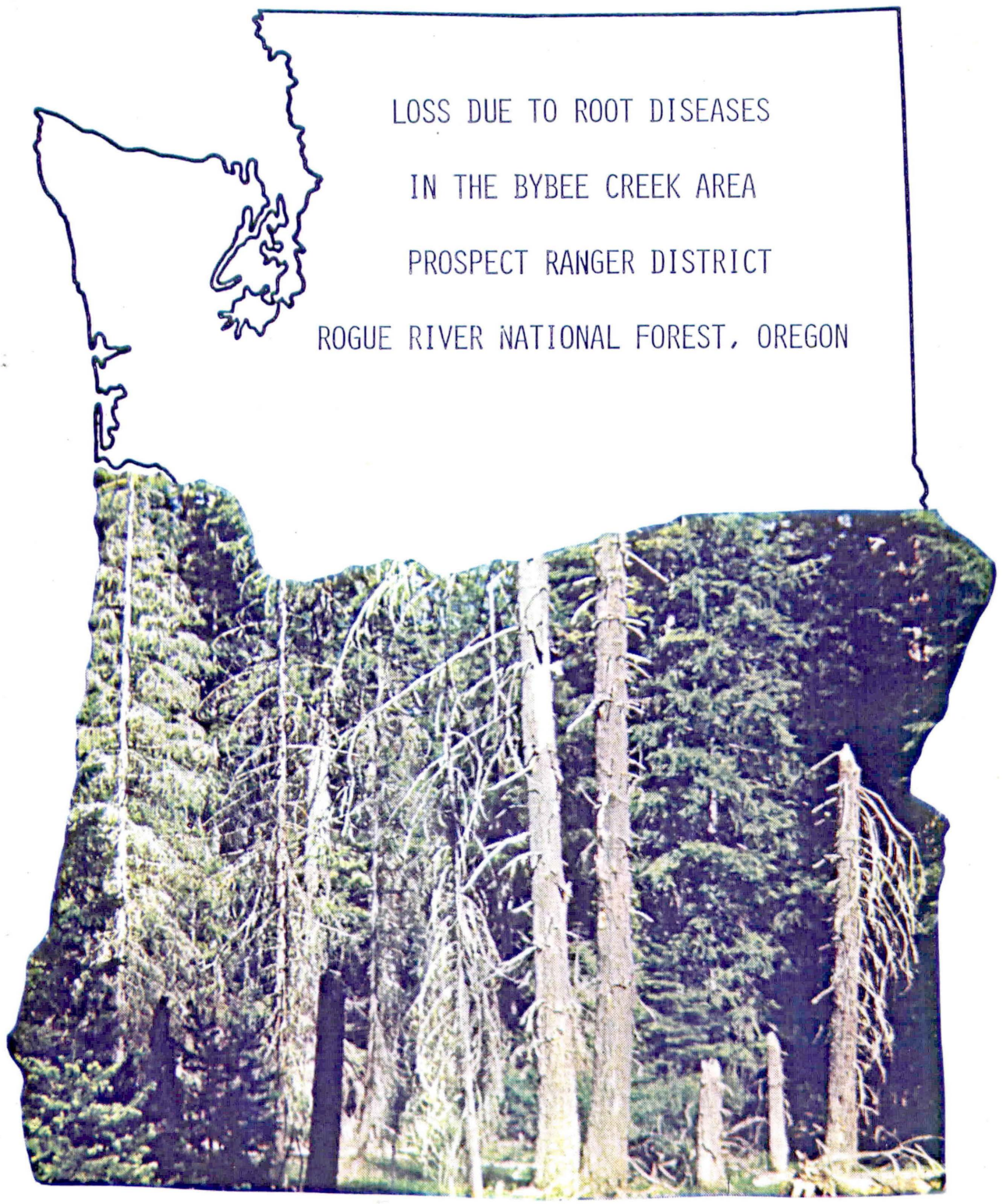
LOSS DUE TO ROOT DISEASES

IN THE BYBEE CREEK AREA

PROSPECT RANGER DISTRICT

ROGUE RIVER NATIONAL FOREST, OREGON



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LOSS DUE TO ROOT DISEASES IN THE BYBEE CREEK AREA, PROSPECT RANGER DISTRICT, ROGUE RIVER NATIONAL FOREST, OREGON

by

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ABSTRACT

Timber loss due to root disease-caused tree mortality was measured over a 40-acre area near Bybee Creek. Of a mean of 925.5 trees per acre $\geq$6.0 in, in height, 80.7 (8.7%) representing 11.7% of the basal area and 12.0% of the boardfoot volume were dead or dying as a result of root diseases over the last 20 years.

Armillaria mellea was the principal root disease found and was affecting primarily white fir. A management scheme based on favoring relatively disease-tolerant species as determined from this evaluation should reduce future losses. Because of the level terrain, excavation of infected stumps following stand removal may be feasible and desirable to reduce future damage.

INTRODUCTION

Root diseases are causing severe damage in many areas of the Pacific Northwest. Damage occurs as tree mortality and growth loss in living infected trees. Many stands experience significant and long lasting reductions in productivity as a result of continuing mortality.

The two most common root diseases in the grand/white fir type in the Region are Armillaria root rot caused by *Armillaria mellea* (Vahl ex Fr.) Quel. and laminated root rot caused by *Phellinus weirii* (Murr) Gilbertson. Wood volume losses of 70 ft^3/acre/year and 85 ft^3/acre/year have been reported in grand/white fir type in Oregon, caused by *A. mellea* and *P. weirii*, respectively (Filip 1980, Goheen 1980).

Another frequently encountered disease, annosus root rot caused by *Fomes annosus* (Fr.) Cke., commonly causes a root and butt rot of true fir rather than tree mortality in the Region.

Armillaria mellea and *P. weirii* spread from tree to tree via root contacts and grafts. They commonly survive in old-growth stumps of the previous overstory. Infected stumps can serve as fungal food bases for several decades. When newly established trees come into contact with this inoculum, they can become infected. *Fomes annosus* spreads long distances by windborne spores that infect fresh wounds or cut stump surfaces. Once established, it also spreads from tree to tree along roots.

This report documents the results of a survey on an area located within the Prospect Ranger District, Rogue River National Forest, near the western boundary of Crater Lake National Park (T. 30 S., R. 4 E., Sec. 8, Fig. 1). This area was selected for examination because the Forest had suggested the need to establish an area that could be used to demonstrate stump removal as a technique to control root disease.

OBJECTIVES

Objectives of this evaluation were to:

1. Determine per acre losses of trees, basal area, and volume due to root diseases and other causes of tree mortality over a 40-acre area.

2. Determine the distribution and intensity of root disease over the area.

3. Develop management alternatives to reduce present and future mortality caused by root diseases.

METHODS

Plot Establishment

The line-point sampling method, using a 2x2 chain grid, was selected to assure that all areas would be surveyed thoroughly. At each plot, trees $\geq$5.0 in. DBH were tallied with a prism (40 BAF) and trees $<$5.0 in. DBH but $\geq$6.0 in. in height were tallied on fixed-area circular plots (1/100 acre).

Data recorded for each tree included: (1) species, (2) DBH (approximated for stumps), (3) condition (live, recently killed, snag, stub, or harvested stump), and (4) presence of root diseases. All symptomatic (chlorotic, ragged crowns, etc.) or dead trees and stumps were examined for root diseases. Two roots, one on either side of the tree, were excavated for a distance of 3 feet from the root collar. Root surfaces were checked for ectotrophic mycelium of *Phellinus weirii*. Bark was removed and roots checked for mycelial fans of *Armillaria mellea*. Finally, root wood was examined for laminated rot caused by *P. weirii*, yellow-stringy rot caused by *A. mellea*, or white stringy rot caused by *F. annosus*. No attempt was made to culture pathogens or determine presence of infection in living, non-symptomatic trees.

RESULTS

Stand Composition

White fir was the most common tree species in the stand surveyed. Of an average 925.5 trees per acre $\geq$ 6.0 in. in height, 642.4 (69.4%) were white fir, 107.7 (11.6%) were ponderosa pine, 126.9 (13.7%) were Douglas-fir, and 48.5 (5.3%) were other species (Table 1). White fir also had the highest basal area figure of all species. Of 248.9 feet^2 per acre, 114.7 (46.0%) were white fir, 76.1 (30.6%) were ponderosa pine, 52.0 (20.9%) were Douglas-fir, and 6.1 (2.5%) were other species (Table 2). Although white fir was the most numerous tree species, it occupied smaller-diameter classes than ponderosa pine and therefore had a lower board foot volume. Of an average 68,377.8 board feet per acre, 27,266.9 (39.9%) were ponderosa pine, 22,633.8 (33.0%) were white fir, 16,318.7 (23.9%) were Douglas-fir, and 2,158.4 (3.2%) were other species (Table 3).

Mortality by Plot Basis

Approximately 40 acres were surveyed using 111 plots (2.8 plots per acre). Of a total of 111 plots, 53 (47.7%) had root disease-caused mortality (Fig. 2). Sixty-four percent of the diseased plots had one-quarter or more of the basal area killed by root disease.

Mortality Agents

Armillaria root rot was the primary cause of mortality in the area surveyed. Although laminated root rot, caused by *Phellinus weirii*, was found in the survey area, it was not causing significant losses. Annosus root rot was found in stumps of some harvested trees but it did not appear to be causing mortality of standing trees. Some of the larger white firs were infected with heart-rot fungi, mainly *Echinodontium tinctorium* and *Fomes pini*. *Fomes pini* and a butt-rot fungus, *Phaeolus schweinitzii*, were found on some of the large Douglas-firs in the survey area.

In order to simplify data analysis, losses caused by Armillaria root rot, laminated root rot, and Annosus root rot were combined under the category "dead-infected." Mortality due to other causes was combined under the category "dead-other."

Tree Stocking - Mortality Relationship

The number of trees per acre in root-diseased plots was higher than that in healthy plots: 287.3 versus 218.9. However, live trees in diseased plots averaged 213.6 trees per acre. Trends in basal area were similar: diseased plots averaged 262.1 ft^2 per acre of which 203.7 ft^2 were live. Healthy plots averaged 219.7 ft^2 per acre.

Tree Species - Mortality Relationship

A comparison of the percent of trees per acre that were dead and root-infected shows that 10.9% of the white fir, 4.9% of the ponderosa pine, and 4.0% of the Douglas-fir were dead-infected (Table 1).

Basal area comparisons of dead infected trees show that 20.4% of the white fir, 4.9% of the ponderosa pine, and 3.8% of the Douglas-fir were dead-infected.

Board-foot volume comparisons of dead-infected trees show that 21.7% of the white fir, 7.6% of the ponderosa pine, and 7.4% of the Douglas-fir were dead-infected. No root diseases were detected in other tree species. There was no apparent correlation between tree diameter and mortality.

Examination of only diseased plots confirmed the much higher susceptibility of white fir than either ponderosa pine or Douglas-fir to Armillaria root rot:

	Percent Dead-Infected	
Species	Trees per acre	Basal area per acre
White fir	31.5	34.5
Ponderosa pine	19.2	12.7
Douglas-fir	8.3	6.2

DISCUSSION AND CONCLUSIONS

The area examined is experiencing heavy white fir mortality caused primarily by Armillaria root rot. White fir is one of the most susceptible species to root diseases in the Pacific Northwest. Other tree species in the area are not experiencing the same magnitude of loss.

Mortality caused by root disease appears to be more frequent in the higher-stocked plots, where disease is reducing the stocking below that of healthy plots. Armillaria root rot has a history of killing trees weakened first by other causes. Overstocking may be weakening some trees and making them more susceptible to *Armillaria*.

Since the stand examined is overstocked in places, some mortality may be viewed as beneficial. However, root diseases often kill in groups or patches and hence are inefficient thinning agents. There are at least two large disease centers within the surveyed area, parts of which may remain permanently understocked as a result of root disease caused mortality. Furthermore, root infections almost certainly extend beyond symptomatic areas into healthy-appearing parts of the stand, although this was not evaluated in this survey.

Although growth loss due to root disease was not measured in this evaluation, it may be significant in living but infected trees. Some infected trees, particularly the larger diameter classes, may take many years to succumb.

Silvicultural systems discriminating against white fir offer a practical alternative for disease management. Either ponderosa pine or Douglas-fir should be planted or favored in diseased areas. Exclusion of white fir along borders of units will be a problem, but if treatment units are large enough, restocking by white fir will be minimized. Some root disease-caused mortality can be expected in pine or Douglas-fir, but it should be much less than would occur in white fir.

Because of the level topography, removal of infected stumps with heavy machinery may be another option to consider (Roth et al 1977). Stump removal will be the most biologically effective method of reducing root disease caused mortality in the future stand. Tree and stump removal will (1) salvage living diseased trees, (2) create root-free barriers that would limit pocket enlargement and accompanying loss of land from production, (3) destroy root networks that support spread from scattered infections, (4) destroy inoculum and fungal food bases, and (5) prepare a quality seed bed. Forest Insect and Disease Management has funds available to establish areas demonstrating stump removal techniques to control root disease. Such funds may be used in this area by the District to reduce root disease-caused mortality and at the same time demonstrate control techniques.

MANAGEMENT ALTERNATIVES

The following management alternatives for disease reduction are presented for the Bybee Creek area in increasing order of cost and effectiveness of reducing root disease.

(1) No treatment. If this course is followed, losses due to tree mortality will probably average 4.0 trees/acre/year representing 408.7 board feet/acre/year. Losses will probably remain constant.

(2) Sanitation-salvage logging. Most of the volume loss sustained above will be captured. However, loss expressed as infected land area and infected trees per acre will increase, and the number of trees reaching merchantability will decrease even more so than if nothing were done.

(3) Seed tree or shelterwood systems discriminating against white fir. Most of the merchantable timber will be harvested in one or a few operations. Future losses will decrease since white fir is most susceptible to root disease.

(4) Seed tree or shelterwood systems discriminating against white fir with special selection of low disease-risk trees. Loss of leave trees will be decreased even further if special care is taken to mark leave trees that are low risk to root disease, based on their proximity to infected trees or stumps. Forest Insect and Disease Management staff can assist in marking or training of marking crews to recognize low-risk trees.

(5) Clearcut or patchcut systems. All of the merchantable timber will be harvested at once. Any species besides white fir should be regenerated. Although some root infection and mortality will occur as the new stand matures, it will be reduced if white fir is discriminated against.

(6) Clearcut, patchcut, seed tree, or shelterwood systems with stump removal. In addition to the benefits of alternatives 4 and 5, this alternative will be the most effective in reducing infection and mortality in regeneration, including white fir, by removing the bulk of fungus inoculum from the soil. Stumps of infected trees are marked before cutting, and after harvesting, marked stumps are excavated with heavy machinery. Costs on similar sites range from $150-400 an acre to remove and pile stumps and prepare the site for planting.

The information and recommendations presented in this report have been specifically formulated for the area we surveyed. Although some of this information may be applied to other areas in Oregon and Washington experiencing similar root disease problems, these areas may be sufficiently different from the area we surveyed to warrant a separate biological evaluation to formulate management alternatives specific to that area. FIDM pathologists encourage and are available to perform such evaluations at the request of land managers.

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Table 1.--Trees per acre by tree species, size, class, and condition in the Bybee Creek Unit.

DBH Class (in.)	TOTAL			WHITE FIR			PONDEROSA PINE			DOUGLAS-FIR			OTHER SPECIES		
	Healthy	Dead Infected	Dead Other	Healthy	Dead Infected	Dead Other	Healthy	Dead Infected	Dead Other	Healthy	Dead Infected	Dead Other	Healthy	Dead Infected	Dead Other
	Trees per acre														
0.0-0.9	189.2	0	0	154.0	0	0	4.4	0	0	4.4	0	0	26.4	0	0
2.0-4.9	280.5	24.2	13.2	216.7	22.0	11.0	15.4	1.1	2.2	35.2	1.1	0	13.2	0	0
5.0-10.9	192.8	36.4	31.2	111.4	31.1	23.2	21.8	2.9	5.4	54.5	2.4	2.6	5.1	0	0
11.0-20.9	100.3	15.7	6.1	42.6	14.0	3.8	37.5	0.3	1.3	18.4	1.4	1.0	1.8	0	0
21.0-30.9	20.3	3.2	0	6.9	2.7	0	9.1	0.5	0	2.9	0	0	1.4	0	0
31.0-40.9	6.3	0.8	0.5	1.8	0.4	0.25	3.7	0.3	0	0.4	0.1	0.2	0.4	0	0
41.0-50.9	3.25	0.2	0.1	0.4	0.05	0.05	1.4	0.1	0	1.3	0.05	0.05	0.15	0	0
51.0+	0.91	0.15	0.1	0	0.05	0	0.2	0.1	0	0.7	0	0.1	0	0	0
Total	793.6	80.7	51.2	533.8	70.3	38.3	93.5	5.3	8.9	117.8	5.1	4.0	48.5	0	0
Percent	85.8	8.7	5.5	85.0	10.9	4.1	86.9	4.9	8.2	92.8	4.0	3.2	100	0	0

Table 2.--Basal area per acre by tree species, size class, and condition in the Bybee Creek Unit

DBH Class (in.)	TOTAL			WHITE FIR			PONDEROSA PINE			DOUGLAS-FIR			OTHER SPECIES		
	Healthy	Dead Infected	Dead Other	Healthy	Dead Infected	Dead Other	Healthy	Dead Infected	Dead Other	Healthy	Dead Infected	Dead Other	Healthy	Dead Infected	Dead Other
	Basal area (ft^2) per acre														
5.0-10.9	39.9	8.8	4.9	25.7	7.7	3.5	4.8	0.5	1.1	8.8	0.6	0.3	0.6	0	0
11.0-20.9	73.7	9.4	2.7	36.4	8.3	1.5	25.5	0.3	0.6	11.2	0.8	0.6	0.6	0	0
21.0-30.9	38.8	5.9	0.5	15.3	4.8	0	16.5	1.1	0.5	4.2	0	0	2.8	0	0
31.0-40.9	28.9	3.5	0.9	8.0	2.0	0	15.3	1.2	0	4.4	0.3	0.9	1.2	0	0
41.0-50.9	15.3	1.2	0.3	0.6	0.3	0	6.7	0.6	0	7.1	0.3	0.3	0.9	0	0
51.0+	12.4	0.3	1.5	0.3	0.3	0	1.4	0	0	10.7	0	1.5	0	0	0
Total	209.0	29.1	10.8	86.3	23.4	5.0	70.2	3.7	2.2	46.4	2.0	3.6	6.1	0	0
Percent	84.0	11.7	4.3	75.2	20.4	4.4	92.2	4.9	2.9	89.3	3.8	6.9	100	0	0

Table 3.--Board feet per acre by tree species, size class, and condition in the Bybee Creek Unit

DBH Class (in.)	TOTAL			WHITE FIR			PONDEROSA PINE			DOUGLAS-FIR			OTHER SPECIES		
	Healthy	Dead Infected	Dead Other	Healthy	Dead Infected	Dead Other	Healthy	Dead Infected	Dead Other	Healthy	Dead Infected	Dead Other	Healthy	Dead Infected	Dead Other
	Board feet per acre														
5.0-10.9	1579.0	1348.6	438.9	987.4	550.3	309.4	462.1	59.9	129.5	129.5	738.4	0	0	0	0
11.0-20.9	14438.1	1943.6	742.4	5906.2	1717.7	374.6	5626.2	71.1	242.7	2738.0	154.8	125.1	167.7	0	0
21.0-30.9	13019.7	2136.3	252.6	4622.9	1636.5	252.6	5738.8	499.8	0	1719.9	0	0	938.1	0	0
31.0-40.9	12463.3	1278.0	545.1	3586.3	624.7	116.5	7303.9	502.5	0	981.7	150.8	428.6	591.4	0	0
41.0-50.9	10364.6	731.5	325.1	1407.0	178.9	166.5	4762.9	393.8	0	3733.5	158.8	158.6	461.2	0	0
51.0+	5358.4	735.5	677.1	0	196.3	0	934.5	539.2	0	4423.9	0	677.1	0	0	0
Total	57223.1	8173.5	2981.2	16509.8	4904.4	1219.6	24828.4	2066.3	372.2	13726.5	1202.8	1389.4	2158.4	0	0
Percent	83.7	12.0	4.3	72.9	21.7	5.4	91.1	7.6	1.3	84.1	7.4	8.5	100	0	0

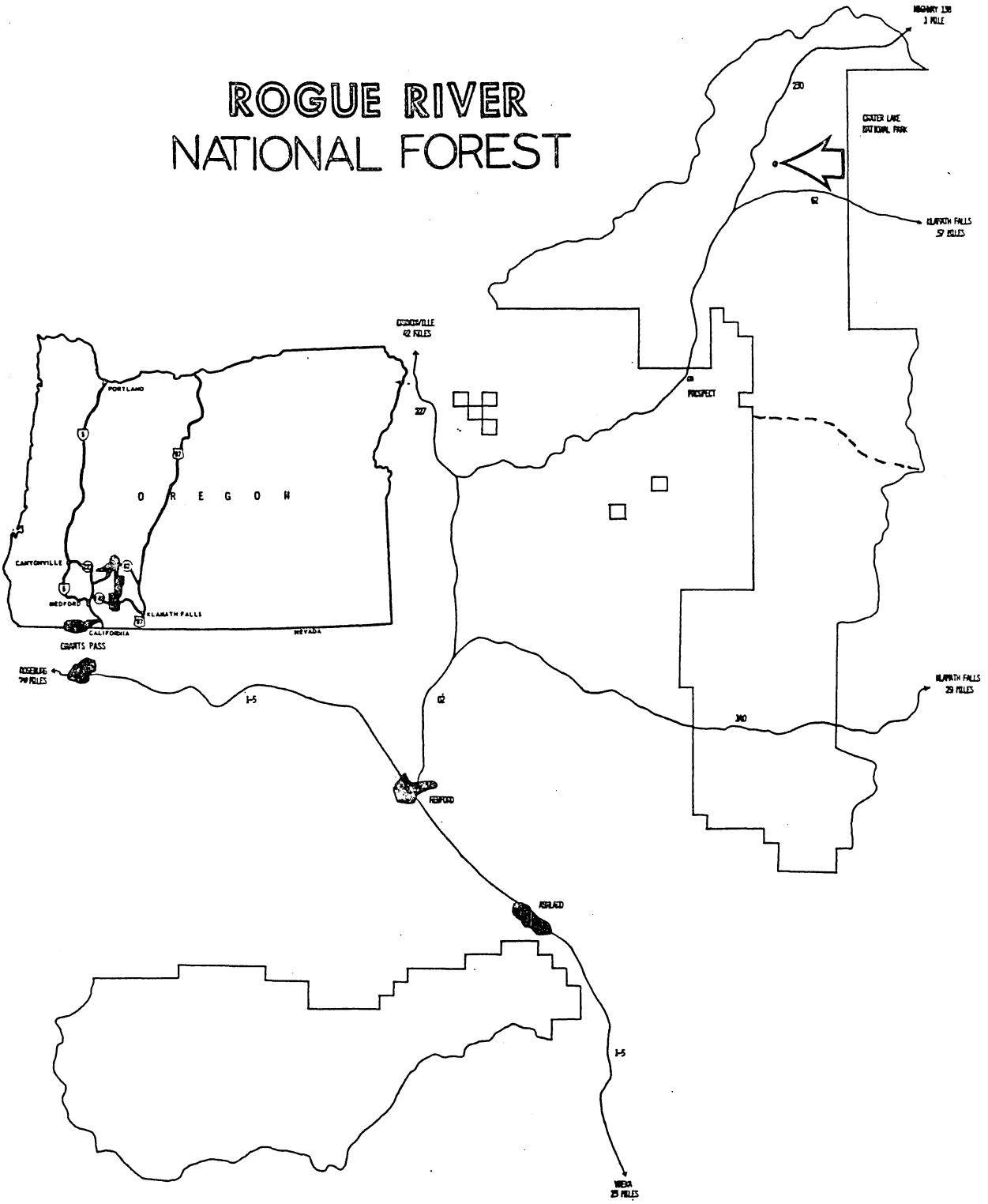

FIGURE 1. Map depicting area surveyed (arrow). Dotted line indicates southern boundary of the Prospect Ranger District.

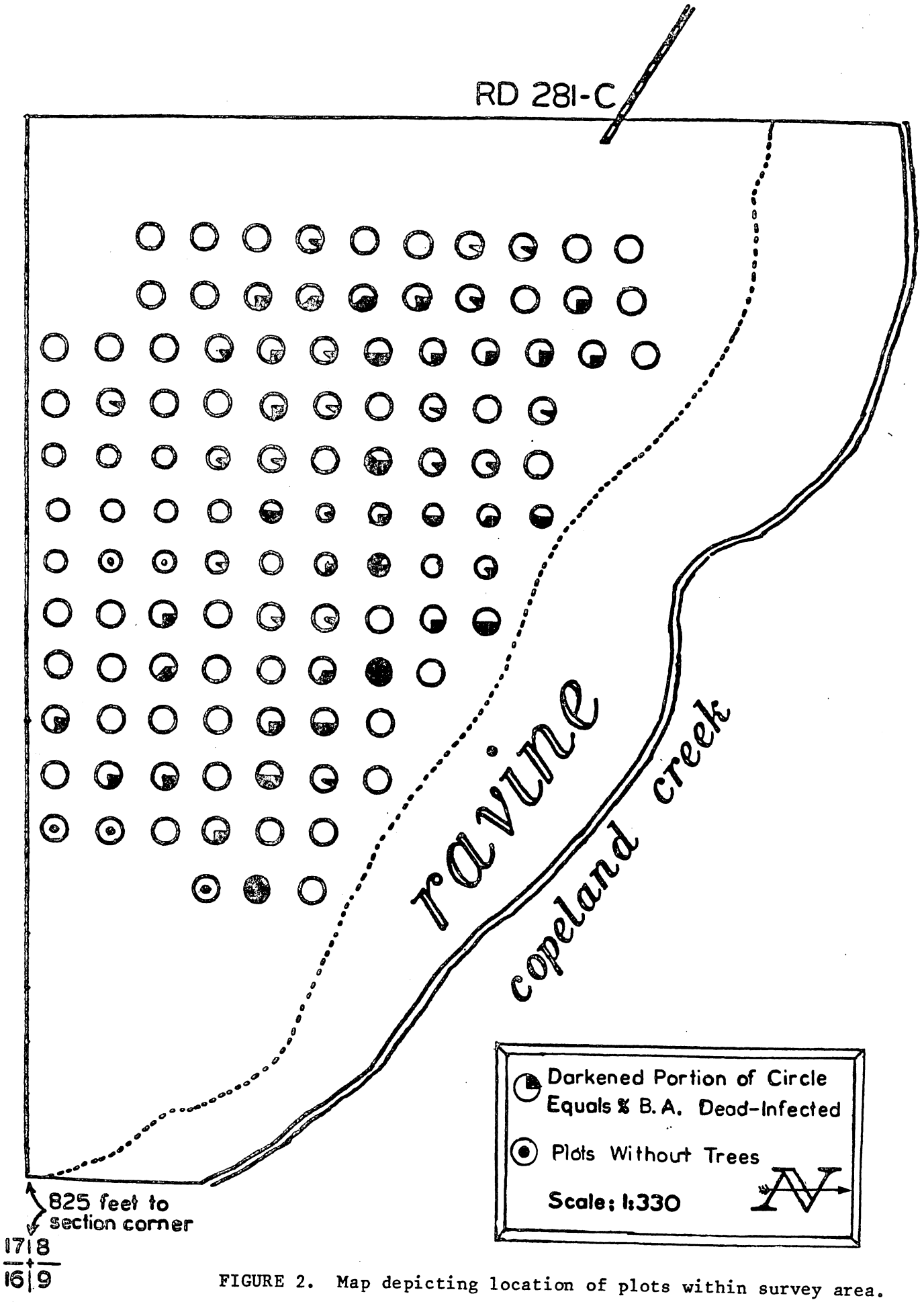

FIGURE 2. Map depicting location of plots within survey area.